Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**New H-ARQ Related IEs for DL/UL-MAP Message**
Date Submitted	**2004-11-1704**
Source(s)	Hang Zhang, Mo-Han Fong, Peiying Zhu, Wen Tong Nortel Networks Yigal Leiba, Yossi Segal, Zion Hadad, Itzik Kitroser, Eli Shasha Runcom Ltd. ~~3500 Carling Avenue, Ottawa Ontario, Canada K2H 8E9~~
	mhfong@nortelnetworks.com yigall@runcom.co.il yossis@runcom.co.il zionh@runcom.co.il Itzikk@runcom.co.il shasha@runcom.co.il ~~Voice: +1 613 765 8983 Fax: +1 613 765 6717~~
Re:	IEEE P802.16e/D5-2004
Abstract	This contribution introduces new H-ARQ related IEs to DL/UL-MAP message. This is a revised contribution. Changes are highlighted in blue.
Purpose	Review and Adopt the suggested changes into P802.16e/D5
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

1 Introduction

In current DL/UL MAP IE, there is no IE designed for H-ARQ operation. In this contribution, some new types of DL/UL IEs are introduced to enable various H-ARQ operation.

This contribution includes the following components:

- For DL, the following IEs are introduced:
  - ~~oIR based~~ H-ARQ for non-MIMO capable MSS – ~~IR~~ H-ARQ ~~MAP~~ Burst IE
    - ~~Chased based H-ARQ for non-MIMO capable MSS – Chase_H-ARQ IE~~
    - ~~IR based~~ H-ARQ for MIMO-capable MSS – MIMO_~~IR~~ H-ARQ Burst_IE
  - ~~oChase based H-ARQ for MIMO-capable MSS – MIMO_Chase_H-ARQ IE~~
    - STC based H-ARQ – STC_H-ARQ_Burst_-IE
- For UL, the following IEs are introduced:
  - ~~IR based~~ H-ARQ for non_MIMO capable MSS – ~~IR~~ H-ARQ ~~MAP~~ Burst IE
  - ~~oChased based H-ARQ for non-MIMO MSS – Chase_H-ARQ IE~~
    - ~~IR based~~ H-ARQ for MIMO-capable MSS – MIMO_~~IR~~ H-ARQ_Burst_-IE
  - ~~oChase based H-ARQ for MIMO-capable MSS – MIMO_Chase_H-ARQ IE~~
    - STC based H-ARQ – STC_H-ARQ IE

To provide the acknowledgment function of H-ARQ, two extra IEs shall be also introduced. The H-ARQ Region allocation IE and H-ARQ BITMAP IE introduced for H-ARQ MAP message can be reused for this purpose.

2 Proposed Text Changes

2.1 HARQ IE for DL-MAP

[Add section 8.4.5.3.x ~~IR~~ HARQ Burst~~MAP~~ IE]

8.4.5.3.x ~~IR~~ Generic HARQ ~~MAP~~ Burst IE

This IE is transmitted by a BS to one or multiple MSSes that support the optional Generic H-ARQ feature and~~that~~ are running H-ARQ enabled connections ~~and the using IR mode~~.

Table xx. ~~IR~~ H-ARQ ~~MAP~~ Burst IE.

Syntax	Size (bits)	Note
~~IR~~ H-ARQ_Burst_IE() {		
Extended DIUC	4 bits	H-ARQ = 0x09
Length	4 bits	
Num_Assignments	2 bits	
For (i=0;i<Num_Assignments;i++)		
{		
DIUC	4 bits	
Short Basic CID	~~16~~ 12 bits	12 least significant bits of the Basic CID
OFDMA Symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	000: normal (not boosted); 001: +6dB; 010: -6dB; 011: +9dB; 100: +3dB; 101: -3dB; 110: -9dB; 111: -12dB;

No. OFDMA offset	8 bits	
No. subchannel offset	6 bits	
Repetition coding indication	2 bits	0b00 - No repetition coding 0b01 - Repetition coding of 2 used 0b10 - Repetition coding of 4 used 0b11 - Repetition coding of 6 used
ACID	3 bits	H-ARQ channel ID
Packet_SN	1 bits	Packet sequence number. When changed, it means a new packet is been transmitted
SPID	2 bits	Sub-packet ID
}		
Padding bits	Variable	Padding bits to align boundary of byte
}		

DIUC
DIUC used for the burst.

Packet_SN
Defines ARQ Identifier Sequence Number. This is toggled between '0' and '1' on successfully transmitting each encoder packet with the same ARQ channel.

SPID
Defines SubPacket ID, which is used to identify the four subpackets generated from an encoder packet.

ACID
Defines H-ARQ Channel ID, which is used to identify H-ARQ channels. Each connection can have multiple HARQ channels, each of which may have an encoder packet transaction pending.

Short Basic CID
12 least significant bits of the Basic CID

OFDMA Symbol offset
The offset of the OFDMA symbol in which the burst starts, measured in OFDMA symbols from beginning of the downlink frame in which the DL-MAP is transmitted.

Subchannel offset
The lowest index OFDMA subchannel used for carrying the burst, starting from subchannel 0.

No. OFDMA Symbols
The number of OFDMA symbols that are used (fully or partially) to carry the downlink PHY Burst.

No. of subchannels
The number of subchannels with subsequent indexes, used to carry the burst.

Repetition coding Indication
Indicates the repetition code used inside the allocated burst.

~~*[Add section 8.4.5.3.x Cahse_HARQ MAP IE]*~~

~~8.4.5.3.x Chase_HARQ MAP IE~~

~~This IE is transmitted by a BS to one or multiple MSSes that are running H-ARQ enabled connections and using Chase mode.~~

~~Table xx. Chase_H-ARQ MAP IE.~~

~~Syntax~~	~~Size (bits)~~	~~Note~~
~~Chase_H-ARQ_IE()~~		
~~Extended DIUC~~	~~4~~	~~H-ARQ = 0x09~~
~~Length~~	~~4~~	
~~Num_Assignments~~	~~2~~	
~~For (i=0;i<Num_Assignments;i++)~~		
~~{~~		
~~DIUC~~	~~4~~	
~~CID~~	~~16~~	
~~OFDMA Symbol offset~~	~~8~~	
~~Subchannel offset~~	~~6~~	
~~Boosting~~	~~3~~	
~~No. OFDMA_offset~~	~~8~~	
~~No. subchannel offset~~	~~6~~	
~~Repetition coding indication~~	~~2~~	
~~ACID~~	~~3~~	~~H-ARQ channel ID~~
~~Tx_Count~~	~~2~~	~~Transmission count: 00: first transmission 01: second transmission 10: third transmission 11: fourth transmission~~
~~}~~		
~~Padding bits~~	~~Variable~~	~~Padding bits to align boundary of byte~~
~~}~~		

[Add section 8.4.5.3.x MIMO_~~IR~~_HARQ ~~MAP~~ Burst IE]

8.4.5.3.x MIMO_~~IR~~_HARQ ~~MAP~~ Burst IE

This IE is transmitted by a BS to one or multiple MIMO-capable MSSes that support the optional Generic H-ARQ feature and are running H-ARQ enabled connections. ~~and using IR mode.~~

Table xx. MIMO_~~IR~~_H-ARQ ~~MAP~~ Burst IE.

Syntax	Size (bits)	Note
~~I~~MIMO_~~IR~~_H-ARQ_IE() {		
Extended DIUC	4 bits	H-ARQ = 0x09
Length	4 bits	
Num_Assignment	2 bits	
For (i=0;i<Num_Assignment;i++)		
{		

_OFDMA Symbol offset	8 bits	
_Subchannel offset	6 bits	
_Boosting	3 bits	
_No. OFDMA_offset	8 bits	
_No. subchannel offset	6 bits	
_Repetition coding indication	2 bits	
_Matrix_indicator	2 bits	
_Num_Layer	2 bits	
_For i=0;i<Num_Layers;i++)		
_{		
__Short Basic CID	12 bits~~6~~	
__DIUC	4 bits	
__Layer_index	2 bits	
__ACID	3 bits	H-ARQ channel ID
__Packet_SN	1 bits	Packet sequence number. When changed, it means a new packet is been transmitted
__SPID	2 bits	Sub-packet ID
__}		
_}		
Padding bits	Variable	Padding bits to align boundary of byte
}		

~~*[Add section 8.4.5.3.x MIMO_Cahse_HARQ MAP IE]*~~

~~8.4.5.3.x MIMO_Chase_HARQ MAP IE~~

~~This IE is transmitted by a BS to one or multiple MIMO capable MSSes that are running H-ARQ enabled connections and using Chase mode.~~

~~**Table xx. MIMO_Chase_H-ARQ MAP IE.**~~

Syntax	Size (bits)	Note
MIMO_Chase_H-ARQ_IE()		
Extended DIUC	4	H-ARQ = 0x09
Length	4	
Num_Assignment	2	
For (I =0;i<Num_Assignment;i++)		
{		
OFDMA Symbol offset	8	
Subchannel offset	6	
Boosting	3	
No. OFDMA_offset	8	
No. subchannel offset	6	
Repetition coding indication	2	
Matrix_indicator	2	
Num_Layer	2	
For i=0;i<Num_Layers;i++)		
{		
CID	16	
DIUC	4	
Layer_index	2	
ACID	3	H-ARQ channel ID
Tx_count	2	Transmission count 00: first transmission 01: second transmission 10: third transmission 11: fourth transmission
}		
}		
Padding bits	Variable	Padding bits to align boundary of byte
}		

[Add section 8.4.5.3.x STC_HARQ MAP IE]

8.4.5.3.x STC_HARQ MAP IE

This IE is transmitted by a BS to one or multiple MIMO-capable MSSes that support the optional Generic H-ARQ feature and are running H-ARQ enabled connections and using STC mode. The retransmission matrix used depends on the number of BS transmission antenna. (Matrix A (2-transmission antenna, see 8.4.8.9, Matrix B 4-transmission antenna, see 8.4.8.9)

Table xx. STC_H-ARQ MAP IE.

Syntax	Size (bits)	Note
STC_H-ARQ_IE()		
Extended DIUC	4 bits	H-ARQ = 0x09
Length	4 bits	
Num_Assignments	2 bits	
For (i=0;i<Num_Assignments;i++)		
{		
DIUC	4 bits	
Short Basic CID	12~~6~~ bits	
Tx_count	2 bits	00: first transmission 01: second transmission 10: third transmission 11: fourth transmission
If (Tx_count == 00)		
{		
OFDMA Symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	
No. OFDMA_offset	8 bits	
No. subchannel offset	6 bits	
Repetition coding indication	2 bits	
}		
ACID	3 bits	H-ARQ channel ID
}		
Padding bits	Variable	Padding bits to align boundary of byte
}		

2.2 HARQ IE for UL-MAP

[Add section 8.4.5.4.x ~~IR~~ HARQ ~~MAP~~ Burst IE]

8.4.5.4.x ~~IR~~ HARQ ~~MAP~~ Burst IE

This IE is transmitted by a BS to one or multiple MSSes that support the optional Generic H-ARQ feature and are running H-ARQ enabled connections ~~and the using IR mode~~.

Table xx. ~~IR~~ H-ARQ ~~MAP~~ Burst IE.

Syntax	Size (bits)	Note
~~IR~~ H-ARQ_Burst_IE()		
Extended UIUC	4 bits	~~IR~~ H-ARQ = 0x09
Length	4 bits	
Num_Assignments	2 bits	
For (i=0;i<Num_Assignments;i++)		
{		
UIUC	4 bits	
Short Basic CID	12 bits~~6~~	12 least significant bits of the Basic CID
Duration	10 bits	In OFDMA slots (see 8.4.3.1)
Repetition coding indication	2 bits	0b00 - No repetition coding 0b01 - Repetition coding of 2 used 0b10 - Repetition coding of 4 used 0b11 - Repetition coding of 6 used
ACID	3 bits	H-ARQ channel ID
Packet_SN	1 bits	Packet sequence number. When changed, it means a new packet is been transmitted
SPID	2 bits	Sub-packet ID
}		
Padding bits	Variable	Padding bits to align boundary of byte
}		

UIUC
UIUC used for the burst.

Packet_SN
Defines ARQ Identifier Sequence Number. This is toggled between '0' and '1' on successfully transmitting each encoder packet with the same ARQ channel.

SPID
Defines SubPacket ID, which is used to identify the four subpackets generated from an encoder packet.

ACID
Defines H-ARQ Channel ID, which is used to identify H-ARQ channels. Each connection can have multiple HARQ channels, each of which may have an encoder packet transaction pending.

Short Basic CID
12 least significant bits of the Basic CI

Duration
Indicates the duration, in units of OFDMA slots, of the allocation.

Repetition coding Indication
Indicates the repetition code used inside the allocated burst.

~~*[Add section 8.4.5.4.x Cahse_HARQ MAP IE]*~~

~~8.4.5.4.x Chase_HARQ MAP IE~~

~~This IE is transmitted by a BS to one or multiple MSSes that are running H-ARQ enabled connections and using Chase mode.~~

~~Table xx. Chase_H-ARQ MAP IE.~~

~~Syntax~~	~~Size (bits)~~	~~Note~~
~~Chase_H-ARQ_IE()~~		
~~Extended UIUC~~	~~4~~	~~Chase_H-ARQ = 0x09~~
~~Length~~	~~4~~	
~~Num_Assignments~~	~~2~~	
~~For (i=0;i<Num_Assignments;i++)~~		
~~{~~		
~~UIUC~~	~~4~~	
~~CID~~	~~16~~	
~~Duration~~	~~6~~	
~~Repetition coding indication~~	~~2~~	
~~ACID~~	~~3~~	~~H-ARQ channel ID~~
~~Tx_Count~~	~~2~~	~~Transmission count: 00: first transmission 01: second transmission 10: third transmission 11: fourth transmission~~
~~}~~		
~~Padding bits~~	~~Variable~~	~~Padding bits to align boundary of byte~~
~~}~~		

[Add section 8.4.5.4.x MIMO_~~IR~~_HARQ Burst~~MAP~~ IE]

8.4.5.4.x MIMO_~~IR~~_HARQ Burst~~MAP~~ IE

This IE is transmitted by a BS to one or multiple MIMO-capable MSSes that support the optional Generic H-ARQ feature and are running H-ARQ enabled connections ~~and using IR mode.~~

Table xx. MIMO_~~IR~~_H-ARQ ~~MAP~~ Burst IE.

MIMO_IR_H-ARQ_Burst IE() {		
Extended UIUC	4 bits	H-ARQ = 0x09
Length	4 bits	
Num_assign	2 bits	
For i=0;i<Num_assign;i++)		
{		
Duration	10 bits	
Collaborative SM_Indication	1 bit	0: Non collaborative SM (assignment to a dual transmission capable MSS) 1: Collaborative SM (assignment to 2 collaborative SM capable MSSes)
If (Collaborative SM_Indication == 0)		
{		
MIMO_Control	1 bit	0: STTD 1: SM
Short Basic CID	12 bits6	Connection ID
UIUC	4 bits	
ACID	3 bits	H-ARQ channel ID
Packet_SN	1 bit	Packet sequence number. When changed, it means a new packet is been transmitted
SPID	2 bits	Sub-packet ID
}		
else		
{		
Short Basic CID	12 bits6	Connection ID. This MSS shall use pilot pattern A
UIUC	4 bits	
ACID	3 bits	H-ARQ channel ID
Packet_SN	1 bit	Packet ID-packet sequence number. When changed, it means a new packet is been transmitted
SPID	2 bits	Sub-packet ID
Short Basic CID	12 bits6	Connection ID. This MSS shall use pilot pattern B
UIUC	4 bits	
ACID	3 bits	H-ARQ channel ID
Packet_SN	1 bit	Packet sequence number. When changed, it means a new packet is been transmitted
SPID	2 bits	Sub-packet ID

[Add section 8.4.5.4.x MIMO_Cahse_ HARQ MAP IE]

8.4.5.4.x MIMO_IR_ HARQ MAP IE

This IE is transmitted by a BS to one or multiple MIMO-capable MSSes that are running H-ARQ enabled connections and using Chase mode.

Table xx. MIMO_Chase_ H-ARQ MAP IE.

MIMO_Chase_H-ARQ_IE()		
Extended UIUC	4	H-ARQ = 0x09
Length	4	
Num_assign	2	
For i=0;i<Num_assign;i++)		
{		
Duration	10	
Collaborative SM_Indication	1	0: Non-collaborative SM (assignment to a dual transmission capable MSS) 1: Collaborative SM (assignment to 2 collaborative SM capable MSSes)
If (Collaborative SM_Indication == 0)		
{		
MIMO_Control	1	0: STTD 1: SM
CID	16	Connection ID
UIUC	4	
ACID	3	H-ARQ channel ID
Tx_Count	2	Transmission count
}		
else		
{		
CID	16	Connection ID. This MSS shall use pilot pattern A
UIUC	4	
ACID	3	H-ARQ channel ID
Tx_Count	2	Transmission count: 00: first transmission 01: second transmission 10: third transmission 11: fourth transmission
CID	16	Connection ID. This MSS shall use pilot pattern B
UIUC	4	
ACID	3	H-ARQ channel ID

[Add section 8.4.5.4.x STC_HARQ MAP IE]

8.4.5.4.x STC_HARQ MAP IE

This IE is transmitted by a BS to one or multiple dual-transmission capable MSSes that support the optional Generic H-ARQ feature and are running H-ARQ enabled connections and using STC mode. The retransmission matrix used is Matrix A (2-transmission antenna, see 8.4.8.9)

Table xx. STC_H-ARQ MAP IE.

Syntax	Size (bits)	Note
STC_H-ARQ_IE() {		
Extended DIUC	4 bits	H-ARQ = 0x09
Length	4 bits	
Num_Assignments	2 bits	
For (i=0;i<Num_Assignments;i++)		
{		
DIUC	4 bits	
Short Basic CID	12 bits~~6~~	
Tx_xount	2 bits	00: first transmission 01: second transmission 10: third transmission 11: fourth transmission
If (Tx_count == 00)		
{		
OFDMA Symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	
No. OFDMA_offset	8 bits	
No. subchannel offset	6 bits	
Repetition coding indication	2 bits	
}		
ACID	3 bits	H-ARQ channel ID
}		
Padding bits	Variable	Padding bits to align boundary of byte
}		

[Add section 8.4.5.4.x ACKCH Region IE for the UL-MAP, to define ACK channels region on the UL]

8.4.5.4.x. ACKCH Region IE

This IE is used by BS to define a ~~DL~~ UL region to include one or more ACK channel(s) for generic H-ARQ supporting MSS. The IE format is shown in Table xx.
The subchannels in the ACKCH region are divided into two half-subchannels. The first half-subchannel is composed of first, third and fifth tiles and the second half-subchannel is composed of second, fourth and sixth tiles. In the ACKCH Region, the 2n-th half-subchannel is the first half-subchannel and the (*2n+1*)-th half-subchannel is the second half-subchannel of the n-th subchannel.
The H-ARQ enabled MSS that receives H-ARQ DL burst at i-th frame should transmit ACK signal through the half-subchannel in the ACKCH region at (*i+j*)-th frame. The frame offset '*j*' is defined by the "H-ARQ ACK Delay for DL Burst" field in the UCD message. The half-subchannel offset in the ACKCH Region is determined by the order of H-ARQ enabled DL burst in the DL MAP. For example, when a MSS receives a H-ARQ enabled burst at i-th frame and the burst is n-th H-ARQ enabled burst amoung the H-ARQ related IEs, the MSS should transmit H-ARQ ACK at *n*-th half-subchannel in ACKCH Region that is allocated by the BS at the (*i+j*)-th frame.

Table xx. ACKCH_region MAP IE format.

Syntax	Size (bits)	Note
ACKCH_Region_IE() {		
Extended DIUC	4	
Length	4	
ACKCH_region_Change_indication	1	0: no region changed 1: region changed
OFDMA Symbol offset	8	
Subchannel offset	6	
No. OFDMA_offset	8	
No. subchannel offset	6	
Padding bits	Variable	Padding bits to align byte boundary
}		

H-ARQ Region Change Indication
Indicates whether the region for generic H-ARQ ACK ~~is~~has changed or not.
OFDMA Symbol offset
Subchannel offset
No. OFDMA Symbols
No. Subchannels
Specify the start symbol offset, the start subchannel offset, the number of allocated symbols and the number of subchannels for the H-ARQ acknowledgement region respectively.

[Add section 8.4.5.3.x HARQ ACK IE for the DL-MAP, for BS to send ACK/NAK on the DL]

8.4.5.34.x. Generic H-ARQ_ACK IE

This IE is used by BS to send H-ARQ acknowledgment to UL Generic H-ARQ enabled traffic. The bit position in the bitmap is determined by the order of the Generic H-ARQ enabled UL bursts in the UL-MAP. The frame offset between the UL burst and the H-ARQACK-BITMAP is specified by "H-ARQ_ACK_Delay_for UL Burst" field in the DCD message.
For example, when a MSS transmits a H-ARQ enabled burst at *i*-th frame and the burst is *j*-th H-ARQ enabled burst in the MAP, the MSS should receive H-ARQ ACK at *j*-th bit of the BITMAP which is sent by the BS at *i*+(frame offset)-th frame.

Table xx. Generic H-ARQ_ACK IE format.

Syntax	Size (bits)	Note
Generic H-ARQ_ACK_IE()		
Extended DIUC	4	
Length	4	
Bitmap Length	6	
Btmap	Variable	
Padding bits	Variable	Padding bits to align byte boundary
}		

BITMAP Length

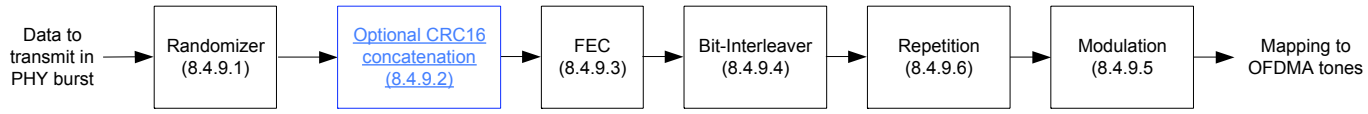
Specifies the length of the following BITMAP field.

BITMAP

Includes H-ARQ ACK information for H-ARQ enabled UL bursts. The size of BITMAP should be equal or larger than the number of H-ARQ enabled UL-bursts.

[On page 260, line 9, add the following text:]

Channel coding procedures include randomization (see 8.4.9.1), FEC encoding (see 8.4.9.3), bit interleaving, (see 8.4.9.4), repetition (see 8.4.9.6), and modulation (see 8.4.9.5). For MSS supporting the generic H-ARQ feature, FEC encoding is preceded by concatenation of a CRC16 (see 8.4.9.2).



8.4.9.2 CRC16 concatenation for optional generic H-ARQ support

For MSS that support the optional GENERIC H-ARQ (but not for MSS the support H-ARQ), a CRC16 checksum shall be concatenated at the randomized data burst that is intended to be placed in a single physical burst (i.e. single MAP allocation). The checksum field provides a means for error detection. The size of the CRC is 16 bits. CRC16-CCITT, as defined in ITU-T Recommendation X.25, and it is calculated over all the bits in the burst.

[On page 294, line 40 add the following text:]

11.8.3.7.8 OFDMA Generic H-ARQ support capability

This field indicates MSS capability of supporting Generic H-ARQ. A bit value of 0 indicates "not supported" while 1 indicates "supported". If this field is omitted, then by default MSS is considered not supporting Generic H-ARQ.

Type	Length	Value	Scope
TBD	1	Bit #0: Generic H-ARQ support Bit #1-7: *reserved*	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)